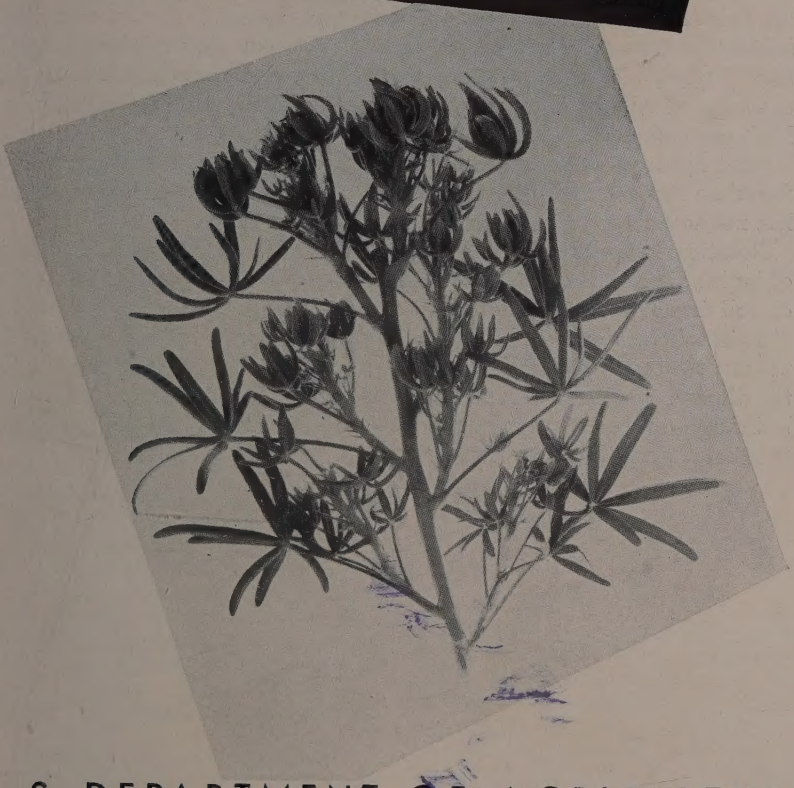
Issued Oct. 1952

Diseases of Cultivated Lupines in the Southeast



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LUPINES HAVE INCREASED in importance as a winter cover and as a seed crop in southern United States since 1937. Blue lupine is the principal cover crop in the Coastal Plain of the Lupine Belt.

Several diseases of lupines are of major importance. They can be divided into two main groups: Those that attack the tops; and those that are limited largely to the roots. The fungus diseases that most commonly attack the tops are anthracnose, brown spot, powdery mildew, botrytis stem canker, sclerotinia stem rot, and ascochyta stem canker. Virus diseases are of minor importance, although they have been known to cause a high percentage of loss in a few fields.

Root diseases caused by fungi are rhizoctonia root rot, southern blight, fusarium root rot, and pythium root rot. Root knot, caused by nematodes, has not so far been a limiting factor in lupine culture.

Rotation is the best control measure generally applicable to a number of lupine diseases. Insofar as possible, disease-free seed should be planted on soil free of the causal fungi.

This bulletin discusses briefly the appearance, or symptoms, of diseased plants; the cause of the disease; and, if known, the control measures for the disease. Several outbreaks of a disease not readily recognized should be brought to the attention of the county agent or to a plant pathologist of the State agricultural experiment station.

Washington, D. C. : Issued October 1952

DISEASES OF CULTIVATED LUPINES IN THE SOUTHEAST[1]

By J. L. WEIMER, *senior pathologist, Division of Forage Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration*

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DISEASES OF LUPINES take a larger toll of the crop than most growers realize. Their severity varies from year to year, depending upon the weather conditions and the prevalence of the causal fungi. Seedlings are so susceptible to root rots and damping-off that stands are sometimes badly depleted by these diseases. Loss of plants in the early stages of growth has made it necessary to increase by a third or more the amount of seed planted. Even heavy seeding does not prevent irregular stands, as diseases usually are more destructive in some parts of a field than in others.

Once the plants emerge from the soil they may be attacked by other diseases. Several of the diseases caused by fungi defoliate the plants, reduce seed production, and may kill the plants. The virus diseases, the causal nature of which is not well known, cause dwarfing and malformation, reduce seed production, and may cause the death of many plants. The root disease caused by nematodes so far does not appear to be a limiting factor in lupine culture if the usual rotation practices are followed.

Blue lupine has increased in popularity as a winter cover and as a seed crop in southern United States so rapidly since 1937 that it now has largely replaced all other cover crops in the Coastal Plain of the Lupine Belt (fig. 1). The acreage of sweet strains of blue and yellow lupines, low in alkaloid content, has been increasing in the Lupine Belt since 1948. These sweet strains provide considerable winter forage, as well as a seed crop. The white lupine is grown to a limited extent in northern locations in the lupine area.

LEAF, STEM, POD, AND SEED DISEASES

Anthracnose

The anthracnose disease [2] is one of the most destructive diseases of lupine in certain sections of the Lupine Belt, especially in southern Georgia and Alabama and northern Florida. It is present, however, as far north as North Carolina and

[1] Investigations were conducted in cooperation with the Georgia Agricultural Experiment Station (Georgia Agricultural Experiment Station Journal Series, Paper No. 214).

[2] Caused by the fungus *Glomerella cingulata* (Ston.) Spauld. & Schrenck.

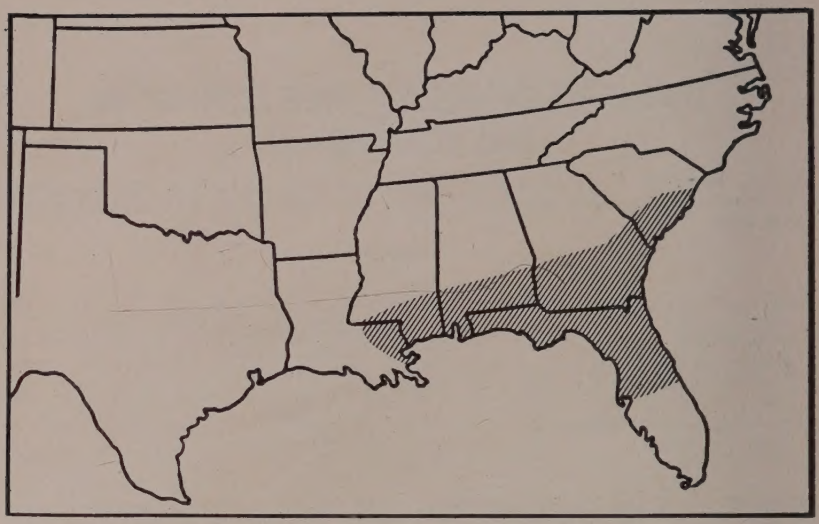

Figure 1.—*Lupine Belt in the United States.*

west into Texas. In some fields a high percentage of the plants may be diseased and many may be killed. In fact, fields are sometimes so badly affected, especially in a very wet season, that there are few or no healthy pods and no seed crop is harvested.

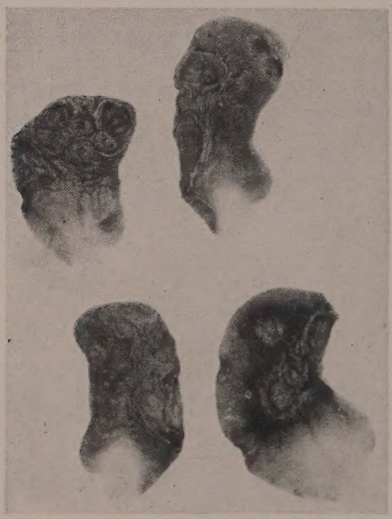

Figure 2.—*Blue lupine cotyledons with circular, sunken lesions caused by anthracnose. Three times natural size.*

The anthracnose fungus can attack fruits of the peach, apple, and plum. It can infect coffeeweed, crotalaria, and many other plants. Although the fungus can be carried to the field in or on lupine seed, it may already be present in the soil or on other plants in the field.

Usually anthracnose appears as small, circular, brownish pits on the seed leaves (cotyledons) of the seedling (fig. 2). These lesions gradually enlarge and soon spread to the stem (fig. 3), which may become girdled. Spores of the fungus causing the disease may be formed on these early spots (lesions) under humid conditions. Spores may be so abundant that they form a salmon-colored layer. These spores can be scattered by splashing of raindrops or by the wind, insects, or any agency that can spread contaminated drops of water. If these spores are kept moist for 24 hours or longer, they will germinate, grow

Figure 3.—*The anthracnose fungus has entered the stem from diseased cotyledons of a blue lupine plant. Natural size.*

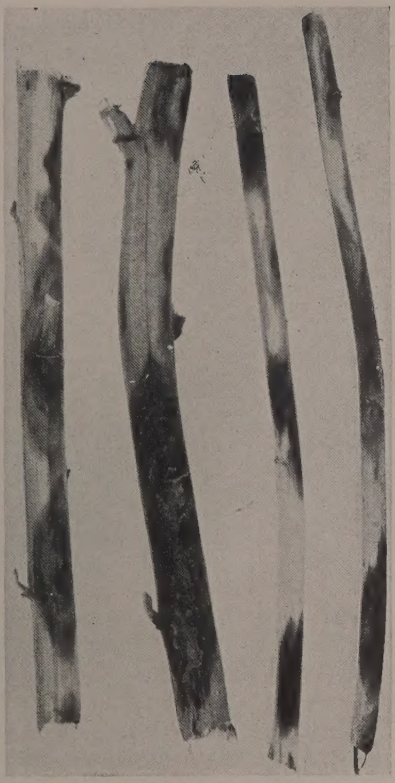

Figure 5.—*Older lupine plants, with anthracnose cankers. These are light to dark brown and often show concentric rings. Natural size.*

Figure 4.—*Stems of blue lupine seedlings, with dark bands (cankers) caused by anthracnose. Slightly enlarged.*

Figure 6.—*Blue lupine leaflets with anthracnose lesions. Slightly enlarged.*

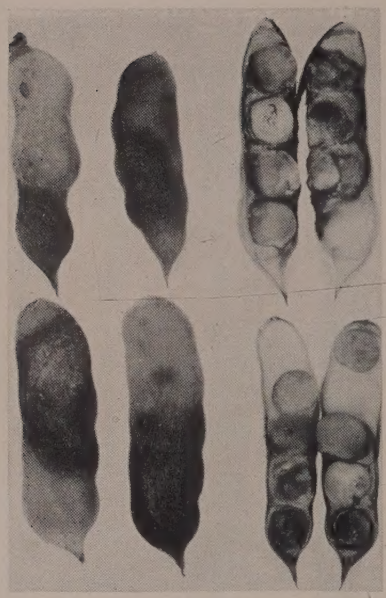

Figure 7.—*Blue lupine pods, showing large, nearly black anthracnose lesions. On the right, several of the seeds have been decayed by the fungus. Natural size.*

into the plant, and start new lesions. Thus, large numbers of new spots are formed on any part of a plant or on nearby plants.

On stems, areas of infection are dark-brown to black bands, often only 1 or 2 inches wide, extending around the stem and sometimes girdling it (fig. 4). As the stem matures, these diseased bands become lighter brown and sometimes are several inches wide. The surface of many of the cankers may show concentric rings (fig. 5).

Blue lupine leaflets usually are not affected seriously. When present, these lesions are circular to irregular in outline, slightly sunken, and dark brown to nearly black (fig. 6). One diseased spot may be sufficient to cause a leaflet to turn yellow and fall.

On pods the infected areas are at first minute, brownish pits. These gradually enlarge and often merge, involving half or more of the pod (fig. 7). Pod lesions are almost black, but they may have one or more salmon-colored masses of spores. As the plants mature and the leaflets fall, the large black areas on the pods are conspicuous.

The seeds beneath the diseased parts are spotted or decayed. Many of the affected seeds are covered with white fungus mycelium (a web of interwoven threads) and may be completely decayed. Seeds less seriously affected have reddish-brown to blackish areas, sometimes with white centers (fig. 8).

On young yellow lupine plants most of the anthracnose lesions are on the leaflets and petioles (leaf-stalks). Infected leaflets of this species do not fall off so readily as do those of the blue lupine. The

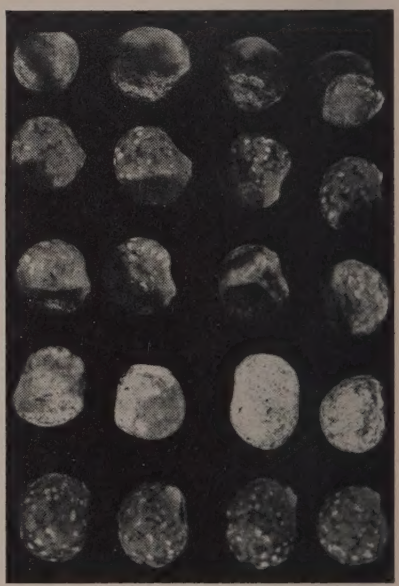

Figure 8.—*Blue lupine seeds, showing several stages of anthracnose infection: The top three rows show different types of lesions; seeds in the fourth row from top are badly decayed and covered with white fungus growth; seeds in bottom row are healthy.*

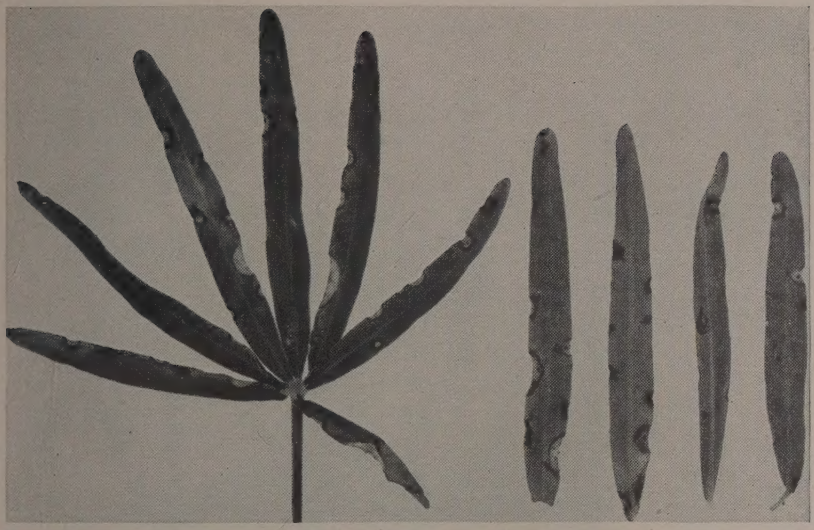

Figure 9.—*Blue lupine leaflets with circular brown spot lesions. The four detached leaflets at the right show the appearance of the lesions on the undersurface. Natural size.*

Figure 10.—*Blue lupine leaflets with line, or netlike, brown spot lesions. Center leaf shows the undersurface. Natural size.*

Figure 11.—*Brown spot lesions on stems of blue lupine. Stems thus affected usually lose their leaflets and die before maturing seed. Slightly enlarged.*

lesions on the yellow lupine are similar to those on the blue species. White lupine is also attacked by the anthracnose fungus and sometimes seriously injured or killed.

Brown Spot

The brown spot disease[3] was probably brought here from Europe in the seed. It is now widespread in this country. This disease seems to do more damage to the lupine crop in the northern part of the area, whereas anthracnose is more destructive in the southern part. The distribution of the two diseases is probably explained by the fact that the brown spot fungus can grow at a lower temperature than can the anthracnose fungus.

On blue lupine the disease is most abundant on the leaflets. The leaflet lesions are variable in size, shape, and color. They may be just visible to the unaided eye or have a diameter equal to the width of the leaflets. Usually the spots are circular, but they may be irregular, especially when two or more lesions have merged or where they have reached the margin of the leaflet (fig. 9). Some lesions consist of fine dark lines or streaks that form an irregular netlike pattern (fig. 10). The spots and streaks and the borders of the larger spots are blackish brown to almost black. Centers of the larger lesions are brown.

The brown spot fungus also attacks the petioles, stems, blossoms, pods, and seeds of blue lupine. On the petioles the spots at first resemble the circular lesions that appear on the leaf or are more elliptical, but later the lesions involve the entire diameter of the petiole and kill it. The surface of the stem may be almost entirely covered with large brownish-black cankers (fig. 11) with slightly lighter borders. Blossom lesions are brownish to black, depending on the part affected (fig. 12). The pod lesions resemble those on the leaflets, and may be few or many (fig. 13). The spots usually remain small, but they may merge and involve a large part of the pod. The causal fungus may grow through the pod wall into the seeds and produce reddish-

Figure 12.—*Small, almost black lesions of brown spot on blossoms of blue lupine. Slightly enlarged.*

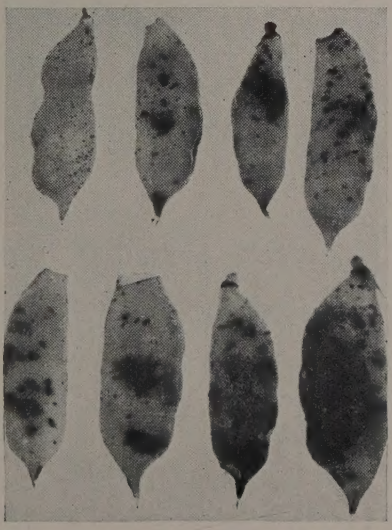

Figure 13.—*Lupine pods affected with brown spot. Many small lesions fuse to form larger lesions. Natural size.*

[3] Caused by *Ceratophorum setosum* Kirch.

Figure 14.—*Brown spot almost completely defoliated lupine plants in large areas of field. Other plants in field had lost only their lower leaves.*

Figure 15.—*Yellow lupine leaflets with typical brown spot lesions: Upper row, top side of leaflets; lower row, underside of leaflets. Natural size.*

brown areas similar to some of the lesions produced on seeds by the anthracnose fungus. Anthracnose decays many seeds, whereas, so far as observed, brown spot produces only a discolored area.

Brown spot of blue lupine causes a great deal of defoliation, often leaving most of the stem bare except for a few of the younger leaves at the top of the plant. Seedlings only a few inches tall and large plants when very seriously affected may be killed (fig. 14).

Brown spot fungus may also attack the yellow and white lupines. Large lesions are produced on the leaflets, many of which are killed (figs. 15, 16). Much, if not all, of the stand is likely to be destroyed.

Powdery Mildew

Powdery mildew,[4] commonly found in most years, especially in

[4] Caused by the fungus *Erysiphe polygoni* DC.

Figure 16.—*White lupine leaflets with brown spot lesions. Slightly enlarged.*

the southern part of the Lupine Belt, attacks the leaves and stems. The fungus produces irregular whitish blotches of varying size that give the plants the appearance of having been dusted with flour. The lower leaves are infected first, but most or all of them are eventually affected. If the disease is severe, many of the leaflets may drop off, thus depriving the plants of the foliage necessary to provide food for maturing their seed. Badly affected plants may produce few or no seed, and the plants may be killed.

Botrytis Stem Canker

Botrytis stem canker [5] is found in varying abundance in blue lupine fields. The fungus attacks plants that have been injured by freezing more readily than unfrozen and otherwise healthy plants. It can, however, infect healthy plants under suitable conditions. This disease is most evident on the stems and large branches, where it produces large brown cankers that, under high-moisture conditions, may be covered with a fluffy, moldy growth consisting of the mycelium and fruiting bodies of the fungus (fig. 17). The pods are sometimes affected by the disease and may be covered by the same moldy growth.

For the most part botrytis stem canker is not serious. It was observed, however, to be widespread in one field where the land had not been plowed and there was an abundance of dead grass left on the surface. The disease was not present in an adjacent field that had been plowed and was free of the cover of dead grass. The disease is seen most often in the spring, when the plants are quite large.

Sclerotinia Stem Rot

Sclerotinia stem rot [6] most commonly attacks and destroys the stems of blue lupine plants. Any

[5] Caused by fungus *Botrytis cinerea* Fr.

[6] Caused by the fungus *Sclerotinia sclerotiorum* (Lib.) D By.

Figure 17.—*Botrytis canker on stems of blue lupine. The fluffy fungus growth on the surface is present only under high humidity. Natural size.*

part of the plant above ground, however, may be attacked and killed. The part above the dead area then wilts and dies. This disease has been found largely in northern Florida. A considerable number of plants in some areas of a field may be attacked, but usually the losses are not serious.

This disease can be distinguished from botrytis stem canker, which it resembles closely, by the white surface mycelium and the irregularly shaped black fungus masses, or sclerotia, in the pith of the stem. Botrytis also produces sclerotia, but these are commonly formed on the surface of the diseased plant rather than within the pith. Sclerotinia stem rot may attack the pods, and small sclerotia may replace the decayed seeds. These sclerotia, which often resemble seeds, may be carried to the field with the seeds and initiate the disease. Therefore, care should be exercised to remove all sclerotia when cleaning the seed.

Ascochyta Stem Canker

Ascochyta stem canker, caused by the same fungus [7] that causes a blight of cotton, has recently been discovered on blue lupine. Thus far the disease has been found only in fields where cotton had been grown during the preceding summer and in which the old cotton stalks were not properly turned under.

Infected lupine seedlings may be girdled by a dark-brown to black canker around the stem that resembles the canker caused by the anthracnose fungus. Plants of any age may be killed. Plants approaching maturity may wilt suddenly and die as the result of large dark-brown cankers on their stems. The ascochyta cankers on young plants are so similar to those caused by the anthracnose fungus that it is often difficult to tell one from the other without microscopic study.

[7] *Ascochyta gossypii* Syd.

Virus Diseases

Although several virus diseases attack lupine in this country, only a few serious outbreaks of these diseases have been reported. More commonly, only a few plants in a field are affected. These diseases cause dwarfing, malformation, yellowing of the foliage, and ultimately death of the affected plants (fig. 18). Plants showing all stages of disease may be in the field at the same time.

Plants affected with a virus disease usually have numerous small branches along the stem bearing small leaves, with the leaflet only one-third to one-half normal size and often curled down and under or standing rigidly upright. Some affected plants are distinctly yellowish and others are reddish, the discoloration being especially apparent in the malformed leaflets. Diseased plants may have brown streaks down one side of the stem, and eventually the whole base of the stem and roots may turn brown and decay. Plants affected late in life often produce a normal or nearly normal crop of seed, whereas those infected earlier usually mature few or no seeds. Some lupine viruses are known to attack many other plants, including peas and cucumbers and some species of weeds. These viruses are carried from plant to plant in the plant juices by such insects as aphids, leafhoppers, and thrips.

ROOT AND CROWN DISEASES

Rhizoctonia Root Rot

Rhizoctonia root rot [8] probably is the most widely distributed and destructive of the root rots of lupines. This disease attacks seedlings before they get above ground,

[8] Caused by the fungus *Rhizoctonia solani* Kuehn.

Figure 18.—*Lupine plant at the left is affected with a virus disease; the one on the right is healthy. One-half natural size.*

and often kills large numbers of them after they emerge by rotting the seedlings off near the surface of the soil (fig. 19). Even plants that have reached the blossoming stage are not immune from attack. It is difficult to distinguish rhizoctonia root rot from similar diseases except by laboratory study. This disease usually causes a reddish rot that may involve a part or all of the underground parts of the plant. Usually young seedlings are largely or entirely decayed and killed; whereas older plants may be injured slightly and show no top symptoms, or they may be dwarfed or slowly killed. Diseased plants usually have yellowish-green foliage and may set no pods.

Southern Blight

Southern blight,[9] largely a disease of the root and crown, affects various kinds of plants, including lupine. Lupine plants are usually attacked near the surface of the soil, and a canker is formed that quickly involves the entire stem and often girdles it (fig. 20). Diseased plants may at first be stunted, but later they wilt and die. Often some white mycelium is seen growing over the surface of the soil about the base of the plant. In dry soil the fungus may attack the roots an inch or more below the soil surface. The roots decay, and often white fungus

[9] Caused by the fungus *Sclerotium rolfsii* Sacc.

Figure 19.—*Stems of yellow lupine seedlings rotted off at the surface of the soil by rhizoctonia root rot. Natural size.*

growth covers the affected part. Typical small, round, white sclerotia, which later turn brown, frequently form on the lesions at or near the surface of the soil or on the adjacent soil, especially in wet weather. Plants of all ages may be killed. Often several neighboring plants or several consecutive plants in a row are attacked, although isolated plants also may be killed. Young seedlings may be girdled and killed in a few days, but death comes much more slowly to older plants. The decayed tissue usually is lighter brown than that caused by rhizoctonia root rot. Southern blight also is distinguished from rhizoctonia root rot by the white mold and white or brown sclerotia formed by the southern blight fungus on parts of attacked plants.

Fusarium Root Rot

Fusarium root rot [10] attacks the root and the underground parts of the lupine stem. Dwarfing, yellowing, and finally wilting and slow death are the characteristic top symptoms produced by fusarium root rot. The disease produces a dry rot on the roots (fig. 21) that ranges in color from water-soaked or straw-colored to mahogany red

[10] Caused by several species of *Fusarium*.

Figure 20.—*White lupine seedlings with stems rotted off by the southern blight fungus. One-half natural size.*

to dark brown, depending on the stage of development, the moisture content of the tissue, and the species of *Fusarium* causing the disease. Under some conditions the fungus attacks a high percentage of the plants in local areas in a field. Not all are killed; some live to maturity without showing any appreciable above-ground symptoms of the disease.

Pythium Root Rot

Pythium root rot [11] commonly causes a root rot or damping-off of the seedlings of lupines. Roots of nearly mature plants, however, may be attacked and killed. The decayed tissue of seedlings is often water-soaked, but it may be some shade of brown (fig. 22). In older plants the bases of the stems, as well as the roots, rot and become very dark brown to almost black.

Root Knot

Roots of blue lupine have been found badly swollen by an attack of the root-knot nematode [12] in only an occasional field (fig. 23). For the most part nematodes do not appear to be a major limiting factor in blue lupine culture. There is no question that this plant is susceptible to attack by root-knot nematodes and that the nematode population of a field may be increased by growing lupines. Affected plants are somewhat yellow and more or less dwarfed and have the characteristic galls on the roots.

These galls should not be confused with the nodules produced by nitrogen-fixing bacteria. The nematodes cause a swelling of the root tissue itself, whereas the nodules produced by the nitrogen-nodule bacteria are more or less globular swellings attached to the side of the root. The interior of the nitrogen nodules is pinkish in color, and the nodules can be detached without breaking the root. Nematode galls, however, cannot be detached from the root and have the same color as the rest of the root tissue.

Figure 21.—*Fusarium root rot of white lupine seedlings. One-half natural size.*

CONTROL MEASURES

Rotation combined with clean seed is recommended as the best control measure for keeping several lupine diseases in check. Of these diseases anthracnose and brown spot are the most serious.

Control of anthracnose should be helped by planting disease-free seed on disease-free land. First-year seed with reddish-brown to blackish lesions should not be planted. If

[11] Caused by several species of *Pythium*.

[12] *Meloidogyne* spp.; formerly *Heterodera marioni* [Cornu] Goodey.

Figure 22.—*Pythium root rot of seedlings of white lupine. Two-thirds natural size.*

the diseased seed cannot be cleaned out, 2-year-old seed of high viability may be used. The fungus in the seed gradually dies and usually is dead by the second planting season after harvest. No chemical seed treatment has proved to be uniformly successful. Hot-water treatment kills the seed before it kills the fungus within; hence, it cannot be used. Heating diseased seed with hot air to 165° F. for 3 hours kills the fungus in the seed, but the seed must be thoroughly dry before it will withstand such a high temperature. Even then, some hard seeds will result and these will germinate slowly. To give the disease-producing fungi in the soil an opportunity to die out, one crop

Figure 23.—*Blue lupine seedling at left is healthy and shows normal nodules formed by nitrogen-fixing bacteria; the two plants at the right show thickening of the roots caused by nematodes. One-half natural size.*

of lupine should not follow another.

The brown spot fungus may be carried to the field in the seed or it may live for an unknown period in the soil. The fungus also is capable of attacking vetch, roughpea, crotalaria, and probably other plants. As some of these plants volunteer, they may serve to keep the brown spot fungus alive in the absence of its lupine host and in this way offset some of the value of rotation as a method of control. It is not known how long the brown spot fungus

lives in the seed, but certainly it survives for more than 2 years. Seed treatment with hot water or with hot air will not eliminate the brown spot fungus without first killing or at least seriously injuring the seed. At present the most effective method of controlling brown spot is to plant disease-free seed on land that has not grown lupines for 3 or 4 years.

No control measure has been found for powdery mildew. Resistant varieties have been reported in Europe, but, so far as is known, no seed is available for commercial planting in the United States.

Ascochyta stem canker usually can be controlled by turning the cotton stalks under completely before planting lupine or lupine should follow a nonsusceptible crop.

No effective control measures for the soil-borne fungi that cause botrytis stem canker, sclerotinia stem rot, southern blight, fusarium root rot, and pythium root rot have been found. Treating lupine seed with chemicals has been studied with varying results at the Alabama, Florida, and Georgia agricultural experiment stations. A considerable number of chemicals have been tested over a period of years. In some tests small increases in stand have been obtained, but not always an increase in plant growth or seed yield. Viability of the seed, soil moisture, kind of fungi in the soil and their abundance, temperature of the soil, and even the mineral composition of the soil may have influenced the results. The small quantity of chemical applied to the seed coat, which soon sloughs off, cannot be expected to protect the plant for any considerable length of time from these soil-inhabiting fungi. Should the grower wish to treat his lupine seed, the same chemicals used for treating other crop seeds, such as those of cotton and peanuts, can be used. Some of these chemicals may injure the nitrogen-fixing bacterial inoculum usually applied to lupine seed at planting time, and poor nodulation may result. This injury can be avoided by applying the inoculum to the soil separately.

Until more is known about the relation of the lupine viruses to viruses of other plants, little can be done about their control in lupine. Since most diseases of lupine that have been studied appear to be caused by the same virus that causes mosaic of English pea and cucumber, one possible control measure is not to plant lupines near a garden or peafield.

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